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# Developing hands-on ergonomics lessons for youth

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## Abstract

By the time students are ready to enter the workforce they have been exposed to up to 20 years of ergonomics risk factors. As technology evolves, it provides more opportunities for intensive repetitive motion and with computers, cell phones, personal digital assistants (PDAs), and electronic games. The average student engages in fewer active physical activities, sit stationary in mismatched furniture in schools for hours and carry heavy backpacks. While long-term effects remain to be identified, increasingly ergonomists and others concerned with musculoskeletal health and wellness, see a need for early ergonomics education. This interactive session provides a hands-on approach to introducing ergonomics to students. Although different approaches may effectively introduce ergonomics at even early stages of development, this program was designed for youth at the middle to high school age. Attendees will participate in four activities designed to introduce ergonomics at an experiential level. The modules focus on grip strength, effective breathing, optimizing your chair, and backpack safety. The workshop will include presentation and worksheets designed for use by teachers with minimal ergonomics training. Feedback from the participants will be sought for further refining the usability and safety of the training package.

*Keywords: Children, student, teacher, training, interactive, lessons*

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## 1. Introduction

A growing body of work in the area of ergonomics is focusing on children and educational environments [1]. This work is revealing the presence of ergonomics risk factors among youth. Children currently use technology as much if not more than adults. They are asked to sit still for hours a day in furniture that does not fit. They are less physically active than previous generations and yet they frequently carry heavy backpacks.

If we suspect that exposure to risk factors may affect the current or future health of children, we may wonder what can be done to prevent or reduce any negative effects of exposure. Introducing ergonomics

information at an early age and continuing to reinforce it in age appropriate ways seems a logical, if challenging strategy. Outreach to youth and the surrounding community may help protect the future work force

Focus groups working on a strategic vision plan for 2025 in a USA National Laboratory identified community outreach, partnerships and the future workforce as key areas for initiatives. This provided a window of opportunity for the ergonomics group to begin to develop tools for introducing ergonomics to students. The resulting training modules focused on providing experiential demonstrations of ergonomics. A goal was to create a toolkit that teachers could use with minimal training accompanied by supporting

documentation, material lists and background materials for teachers.

This hands-on interactive session is designed for participants to experience the ergonomics training modules that have been developed for students. The modules relate to grip strength, effective breathing, optimizing chairs, and backpack safety. Three additional modules were created for lifting, posture and movement, and optimal posture for using a keyboard and mouse, but will not be presented during the session. Attendees will work in pairs or small groups while conducting the activities of each module and recording results on individual worksheets. During the discussion of the results, feedback will be elicited from the participants on the process and materials.

### 1.1 The challenge for school-based ergonomics

Introducing ergonomics in schools requires sensitivity to the surrounding environment in terms of educational standards, teacher workload and student attention capabilities to name a few elements. Teachers are subject to a myriad of requirements and have little time to create new materials. Curriculum is set by local applicable standards and new material must be linked to those standards. Students accustomed to getting information from computers, television and cell phones may have limited capacity for the introduction of material in the written form.

When educators are presented with the idea of introducing ergonomics to students the response is often favourable. However implementation requires overcoming a number of barriers. Some of the barriers to introducing ergonomics in schools have been absence of a link to educational standards, the existing demands on teaching hours, and the absence of easily executable lesson plans. Ergonomics is rarely included in teacher training and professional ergonomics expertise is needed for the development of a class-based program.

## 2. Module design

The goal is to have a toolkit that teachers can use in classrooms with minimal training and expense. Where possible, the content was tied to the educational standards in the State of California, in the USA.

Science standards for grades 5 and 7 include life science content that can be linked. Where math standards address mean, mode and standard distribution, anthropometric measurements such as those gathered in the module on "optimizing your chair" provide ideal data for analysis. It is hoped that

the California Department of Education health standards slated for approval in March 2008 will include additional content that can be linked.

The supply list identifies the items needed and estimates the cost (based upon purchase in California 2005). The general supplies needed such as folders, pencils, etc. as well as equipment needed for each module for about 20 students are specified. The materials and equipment estimates can be extrapolated for different numbers of students and methods of presentation. For example a teacher may want to present just one module for 40 students or may want 20 students to rotate through 4 modules. We would encourage customization to accommodate different situations and needs. The module design illustrates, encourages, and facilitates an understanding and appreciation for ergonomics being a human based science that applies to all individuals.

### 2.1 Toolkit content

The toolkit consists of a number of items (see Table 1).

Table 1  
Written materials for toolkit

Resource	Purpose
Supplies list	Identifies the general supporting supplies needed, the supplies needed for each module, as well as cost estimates for all supplies
Teacher Information Page	Provides information to help trainers including background information, vocabulary, key points, worksheet questions, Q&A, and possible homework assignments for each module
Participants Worksheet	Worksheet for participants to record their own data for each module and to answer questions based on their learning experience. Also used for group discussion or data gathering.
Presentation	For teachers to use to provide students with education about ergonomics and introduce modules; includes speakers notes for presenter
Directions for modules,	These are included in the presentation and a copy to be read by participants while working with a partner.

The items include lesson plans with background material, key points, questions and answers, possible homework assignments and references. The instructions and worksheets for students as well as a description of the materials needed for each module are provided. A pre- and post-test can be administered to test the awareness and understanding of the principles introduced through the modules.

Each module is designed to take the students through introductory material then divide them into small groups to participate in the selected activity or experience. An individual worksheet asks them questions about the experience and guides them to consider implications in their activities of daily living.

### 3. Training module activities

#### 3.1. Grip strength testing

The grip strength section is designed to demonstrate how repetition of the same motion can affect the hand and in general all muscles. A simple bulb grip meter device was selected to keep the cost of the kit low. A standard dynamometer would be more precise but the expense could be prohibitive for educational budgets. Participants are asked to measure and record grip strength before and after squeezing foam objects (see Fig.1). They are instructed to take 3 measurements each time for each hand and average for right and left hands.



Figure 1 Grip strength activity

#### 3.2. Effective breathing

During time spent sitting still at school and elsewhere, especially when using technology, breathing often becomes shallow and circulation can be restricted. The effective breathing module focuses on breathing, circulation and posture. The participants

are instructed to lie on a mat and experience chest and belly breathing while lying on back and stomach. After this the active partner sits in a forward leaning posture (with the rib cage in contact with the upper legs) in a chair while blowing three breaths into a balloon. The balloon is tied off and retained. Then sitting upright (so that the lungs can expand and the rib cage move) they are instructed to blow three breaths into another balloon. When this is tied off and compared to the first balloon there is usually a difference in size. Worksheet questions and teacher notes encourage awareness of breathing and circulation.

#### 3.3. Optimizing your chair

In this module the partners take measurements for each other to allow determination of personal optimal seating height and depth. They are directed to measure popliteal (back of the knee) height and buttock-popliteal length measurements on their partners.



Figure 2 Measuring buttock to back of knee

The popliteal height measurement is taken while the one participant sits on the edge of a table. The partner measures from the tabletop to the heel. This is recorded as the optimal chair height. Then the participant sitting on the tabletop holds a meter/yard stick or a dowel behind the buttocks (see Fig. 2). This allows the partner to measure the distance from the buttock to the back of the knee without physical contact (which could be an issue among students). This measurement is recorded after the approximate width of 3 fingers is subtracted (to avoid contact stress in the sensitive area behind the knee) as the optimal seat depth.

It is suggested and hoped that schools gather this type of anthropometric data as a part of science, math or health lesson plans but also make use of it when

considering classroom furniture purchases.

### 3.4. Backpack safety

Heavy backpacks are used by young students worldwide. Parents, teachers, administrators, and students themselves express concern about the heavy loads that are carried, but rarely know the weight of the backpack or what percentage of body weight is being carried [2]. Professional Associations concerned with children's health such as the American Occupational Therapy Association (AOTA) [3] and the American Academy of Pediatrics [4] advise that students should carry no more than 15% or 10-20% of their body weight, respectively, however researchers often find backpacks exceed 20%.

The structure of this module is a challenge both for safety and to protect any sensitivity about weight. Participants need to weigh themselves and either don their own backpack or load a backpack with 15% of their body weight. When the module is presented in a classroom, students can weigh their own backpacks and determine the percentage of their body weight the backpacks constitute. When the module is presented in a workshop or conference session the participants are instructed to identify the load that would constitute 15% of their body weight. The partner then gradually adds weight (see Fig. 3) checking to determine if the maximum comfortable weight has been reached before the 15% load has been added. The participants are directed to not exceed the 15% load.

## 4. Future plans

To make ergonomics training effective for students, teachers are a key element. For example, in back care training it has been found that teacher participation and reinforcement over time made a significant difference in the extent to which students' fully integrated information that had been introduced in class [5].

The modules have been field tested by teachers in middle school classrooms. One teacher had several hours of orientation and was then able to introduce it to another teacher who had no prior experience.

Further development of the training package will depend upon funding that is presently being sought. It is hoped that a pilot project to train teachers will allow the developers to gain more insight into the elements that most increase the usability and effectiveness.



Figure 3 Backpack safety activity

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